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LSS, a problem solving skill for graduates and SMEs: Case Study of investigation in a UK Business School curriculum

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LSS, a problem solving skill for graduates and SMEs: Case Study of investigation in a UK Business School curriculum

Purpose - This research aims to investigate the feasibility of a systematic Lean Six Sigma (LSS) education through the curriculum of business schools to respond to the existing gap between the graduate's expectation of employability and skill requirements by the Small and Medium Sized Enterprises (SMEs).

Design/approach/methodology - One UK business school has been used as a case study to conduct an extensive module and programme review followed by a semi-structured interview with the potentially suitable core and programme-specific module leaders and also the comparative Analysis between content of these modules and the existing LSS high-street training themes.

Findings – The result revealed a high potential of the existing modules in the business schools equivalent to the private sector training providers to increase the level of LSS problem solving knowledge and skill for all graduates and improve their employability and productivity for the SMEs.

Practical implications/limitations –This research has been carried out in a single UK – based Business School through a qualitative approach. A further in-depth analysis in a broader scale is required to investigate the practical implications in a better way.

Originality/Value –The result of this study highlights the role of LSS to reduce the knowledge and skill gap between the business schools as the source of the explicit knowledge, graduates as the knowledge and skill bearer, and SMEs as the knowledge and skill users.

Key Words – Lean Six Sigma, Problem Solving, Business School, Graduates, SMEs, Knowledge Transfer

1- Introduction

Faced with a fierce global competition, more industrial demand, recent financial austerity and also growing involvement of the private sector, the Higher Education (HE) sector is obliged to be more innovative and proactive in their programmes. Accordingly, business schools are required to increase their mindfulness (Ray et al, 2011), competitive advantage, innovation and distinctiveness in business education (Worasinchai et al, 2008; Blackman and Kennedy, 2009; and Woods and Dennis, 2009). They also need to be engaged in corporate problem solving of Small and Medium Sized Enterprises (SMEs) as the most common employer in the UK economy (Kumar et al, 2011), and graduate employability more effectively (Hamel, 2009; and Anninos and Chytiris, 2011) to improve competitive advantage (Kumarawamy and Chitale, 2012; Worasinchai et al, 2008; and Harrington and Kearney, 2011). SMEs have been defined as organisations with less than 250 employees in the EU definition (Kumar et al, 2011).

The significant gap in the theory/practice interface between business schools as part of academic enterprises, graduates and the industry has been recognised as a current challenge by research studies, but no specific educational programme has been introduced to fill this gap (Reed, 2009). There are also some practical problem solving programmes in the industry that lack theory (Antony, 2008), and are eligible and credible to be embedded in the academic curriculum of business schools to fill the gap (Kumaraswamy, 2012). Business schools are in the competition with the private sector and need relentless change and more effective university-business knowledge collaboration, especially with SMEs for wining competitive advantage (Hughes et al, 2009; and Tikhomirava et al, 2008) to strengthen economic development (Hofer, 2005 and Worasinchai et al, 2008). Recent gaps and differences between business schools as knowledge provider, graduates as knowledge bearer and SMEs as knowledge user have been presented in figure 1. This model reflects the research argument and represents the actual problems in business schools to develop business skills such as problem solving skills for graduates, which is required by SME managers.

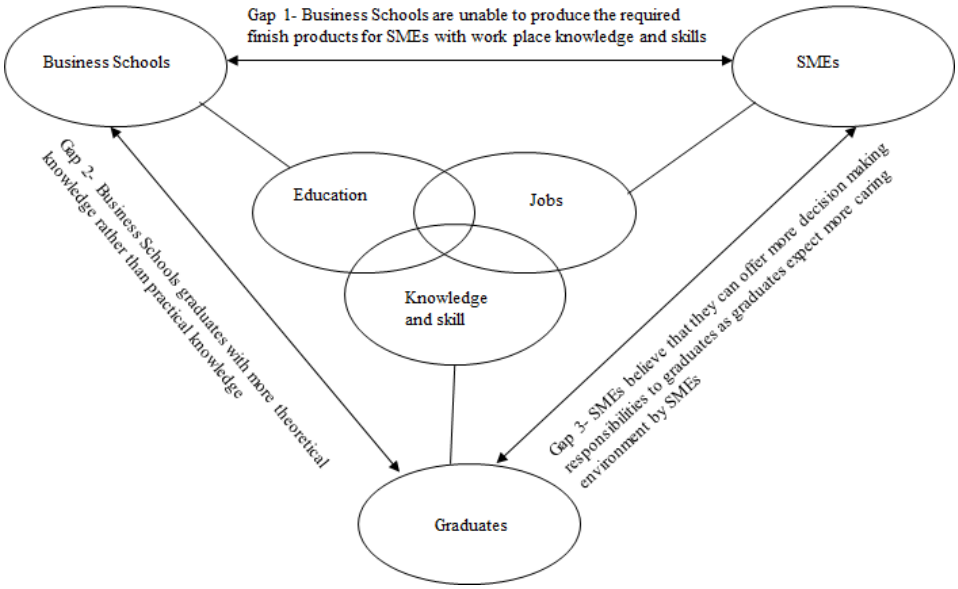

Figure 1 – The gap between business schools, graduates and SMEs

Reversibly, research studies have been criticising the poor involvement of the research in Lean Six Sigma (LSS) as a systematic, training - intensive and practical problem solving tool (Antony, 2012; Antony, 2008; Hilton and Sohal, 2012; and Starkey, 2004). The existing

literature failed to address the role of the LSS in a broader view and in integration with business schools as the enabler to reduce these gaps.

The purpose of this article is to review the contribution of modules and programmes in a business school curriculum to common LSS themes in order to fill these gaps. Leadership, project management, process improvement, operation management, statistical problem solving and performance measurement tools and skills are common LSS themes, which have been highlighted by the literature (Antony, 2014; Prashar, 2014; Antony et al, 2007; Kumar et al, 2011; and Hilton and Sohal, 2012). This would potentially develop LSS integration with both HE and research to enhance skill and employability of graduates and the theoretical approach of the LSS. The detailed inter-relationship between LSS themes and proposed gaps has been indicated in the table 1. This table was produced as the result of an intensive LSS literature review by authors and presents the ideal fitness of LSS themes to fill each gap.

Table 1

The key issue here is to highlight the role of interface between business schools and the LSS in a cost effective and collaborative knowledge transfer (Burke, 2011; and Kumaraswamy and Chitale, 2012) and an innovative knowledge creation (Kumaraswamy and Chitale, 2012; Hughes et al, 2009; Tikhomirova et al, 2008; and Wu and Lin, 2009). The LSS training and education programmes can be distinguished as a tool to transfer the explicit knowledge of the academia, which may have already been static to a tacit knowledge for graduates, which may be dynamic in a continuous learning environment and with the high benefit to SMEs (Wu and Lin, 2009). It is also expected that LSS can facilitate the tacit knowledge transfer to an enhanced explicit knowledge for students through case studies and projects.

2-LSS and knowledge exchange

LSS is widely recognised as a systematic, comprehensive and disciplined methodology that employs statistical and non-statistical tools and techniques to obtain critical knowledge of processes and products essential for reducing the variability and defect, solving problems and achieving both operational and business excellence and customer satisfaction (Antony, 2007; Gijo et al, 2014; Biranvand and Khasseh, 2013; Wu and Lin, 2009; Tracy Zou and Lee, 2010; Aboelmaged, 2010; Manville et al, 2012; Pepper and Spedding, 2010; Braunscheidel et al, 2011; Lee et al, 2011; and Assarlind et al, 2013).

The structured and comprehensive training is a critical success factor of any LSS project alongside the top management commitment, leadership and using statistical tools and techniques (Antony, 2014; Brun, 2011; Manville et al, 2012; Wu and Lin, 2009, Aboelmaged, 2010, Manville et al, 2012; and Hilton and Sohal, 2012). Knowledge management in the current LSS training lacks intellectual capacity, which introduces a challenge (lee et al, 2011). The significance of timely, comprehensive and standardised LSS training has been highlighted by research studies to make it more effective and productive (Laureani, 2012; Pandey, 2007; and Chow et al, 2010; Cho et al, 2011; Manville et al, 2012, Tata and Jones, 2011; and Chow et al, 2010), and to promote creating the knowledge management pool and a continuous tacit and explicit knowledge transfer (Wu and Lin, 2009; and Tracy Zou and Lee, 2010). It was reported by the research outputs that effectiveness and productivity characteristics are missing in the current LSS training provided by the private sector (Laureani, 2012); and there is a need for more rigorous, robust and standardised LSS training to enhance cost efficiency, governance and standardisation.

The evidence from iSixSigma, a key reference electronic LSS source [1] indicates that the LSS belt - training courses are heavily involved in practical and technical aspects of LSS, and would not specifically highlight the business and management aspects such as culture, leadership, Human Resource Management, process and operation management. It also seems that academia has a critical role to design, redesign or modify appropriate modules and programmes to teach leadership, project management, process improvement, operations management, statistical problem solving and performance measurement tools and skills as key themes in LSS training and education (Antony et al, 2007; Kumar et al, 2011; and Hilton and Sohal, 2012).

The degree qualification, proceeding to the higher education or issuing the LSS certification within existing studied HE programme or through breakthrough short training courses will maintain the revealed challenges in governance, cost, and standardisation of the LSS training, education and assessment (Antony, 2012; and Laureani, 2012) for all parties. Figure 2 represents the integrated model of the LSS certification and the LSS education to address the discussed gaps in figure 1. The “Body of Knowledge” presented in figure 2 refers to the intellectual knowledge inside business school, which is provided for students through teaching and learning practices. The “Body of Experience” refers to the tacit knowledge, exploration and skills gained in SMEs, which can be developed through dissertation project

or placements and can be deployed as case studies. The "Certification" in this figure refers to any qualification, which can be provided as the result of studying in the business schools including degree classifications. This model also indicates that LSS knowledge in students can be formally assessed during the summative assessment process in business schools in a more formalised and standardised format. This can be followed by a degree qualification for graduates partly through assessing students in LSS related modules and case studies or projects in SMEs. The students' practical skill can also be initially assessed by SME managers through project management in their dissertation project or even through placement activities in which SME management can also monitor student's competence in practice rather than theory. This could be an interim process for permanent appointment for graduates. The certification process could also be involved with the accreditation and membership in professional bodies that recognise LSS and are usually in collaboration with the business schools.

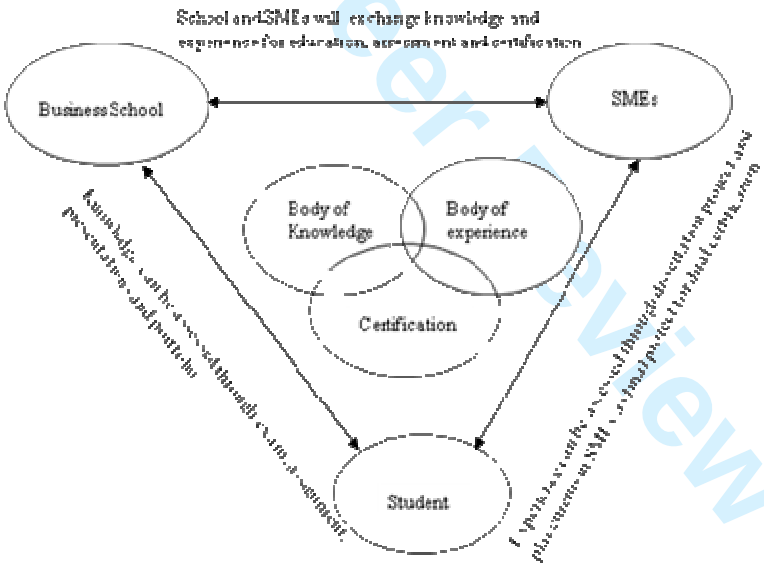

Figure 2 – Integrated model of LSS certification and education

In response to the argument by Antony, 2008 to highlight the research gap in LSS programmes, the result of other research studies revealed that there is a limited LSS knowledge share between academic and organisational environment, which has mainly been focusing on investigation of feasibility of the LSS adoption in organisations including training rather than as immediate evident of motivation to adopt LSS through magnet

curriculum to attract academic research and learning (Aboelmaged, 2010; and Baunscheidel et al, 2011). These arguments instigate the provision of the LSS education as an excellent platform for integrating statistical, managerial and technical tools and skills into any appropriate curriculum of UK based business schools to enhance problem solving and employability skills of graduates.

3- Business schools and LSS knowledge transfer to SMEs

The theory/practice gap in the education/research structure of business schools (Reed, 2009) and the dual potential role of business school and industry in knowledge exchange (Alferoff and Knights, 2009; Scarborough and Knights, 2009; Kieser and Leiner; 2009; Harrington and Kearney, 2011; and Ranjan, 2011) have been highlighted to emphasise requiring significant changes in research and education of these schools (Noorda, 2011; Anninos and Chytiris, 2011; Harrington and Kearney, 2011; Starkey and Tempest, 2008; and Starkey et al, 2004). Business schools aim to prepare the good innovative and insightful managers and leaders with valuable knowledge through teaching common business principles such as human resource management, organisation behaviour, operations management, marketing management, strategic management, supply chain management, finance and accounting.

The role of LSS tool in problem solving of both manufacturing and service SMEs has been in the centre of attention by many academics (Prashar, 2014; Gijo et al, 2014; Kumar et al, 2011; Kumar et al, 2009, Antony et al, 2005; Antony, 2008; lee-Mortimer, 2006; Kaushik et al, 2012; Antony and Desai, 2009; Laureani, 2012, Hilton and Sohal, 2012 and Manville et al, 2012). Organisational learning capabilities, leadership (Antony, 2014; Suresh et al, 2012; and Malik and Blumenfeld, 2012), personal and corporate competence of the project leaders, project team and facilitators (Hilton and Sohal, 2012) and also appropriate technical capabilities (Malik and Blumenfeld, 2012) have been highlighted by the literature as critical subjects to succeed in any LSS project. These subjects can be discovered immensely as academic subjects in the Undergraduate (UG) and Post Graduate (PG) academic curriculums of business schools to develop insightful managers and leaders to deal with business problems.

The application of LSS in academic business disciplines such as financial services (Pandry 2007, Antony, 2007; and Delgado, 2010), Human Resource departments (Pandry, 2007; and Chow et al, 2010), information management systems and administration processes (Antony et

al, 2012), strategic management and managerial decision making (Friday-Stroud and Sutterfield, 2007), customer satisfaction analysis (Behara et al, 1995) and supply chain management and logistics (Shokri et al, 2010, Nabhani et al, 2009; Narasimhan, 2009; and Aboelmaged, 2010) has also been highlighted by the literature.

There is a very little evidence of the cohesive knowledge and information sharing within an enhanced circle of collaborative knowledge exchange between SMEs, Business Schools and graduates, which makes business schools failed to provide challenging and stimulating experiences for their graduates (Bickerstaffe and Ridgers, 2007; and Reed, 2009). Business schools can play bigger role to enhance this circle through proactive approach of the LSS teaching or the incremental LSS training for SMEs through placement, dissertations or research projects. The systematic problem solving knowledge and the skill development nature of the LSS education would adhere to the development of a cohesive circle of collaborative knowledge exchange between these three stakeholders.

This study intends to evaluate the potential idea of using the presented LSS themes as an innovative graduate skill development approach in the business - related UG and PG modules and courses to enrich the distinctiveness of the research and professional – integrated modules and the graduate employability in the UK or EU business schools.

4-Research Background and Case review

This section intends to provide useful information about the HE case study institution, process of sampling, data collection and data analysis. A broad review of all modules and programmes and also some open - end interviews have been conducted in a UK based business school accommodating nearly 4470 students in UG, PG and doctoral levels through six different subject groups. This business school has employed 131 academic staff that 80% of them were academically qualified (completed a doctoral degree), While another 20% are professionally qualified (having master degrees with senior management experience in their previous industrial background). The intellectual contributions of the school has been around 1160 publications with 15% of them as peer reviewed journal articles in which 40% of those articles have had contribution to practice. There were 24 active UG and 18 PG programmes or courses that recruit students globally.

As the first step, teaching and learning outcomes and material of all delivered modules in the business school have been reviewed through analysing the module descriptors and teaching and learning plans to identify the suitable modules that potentially can fit LSS themes in their teaching structure. The programme specifications have also been reviewed to identify the taught modules, structure and also other useful information for these programmes. Having identified the suitable modules and programmes (courses) and through a purposive sampling technique, six core UG, and ten core PG modules were selected alongside a few suitable programme-specific modules as sample to conduct an un–structured interview with their module leaders. The sampling was conducted through the purposive method in which appropriate modules were identified as the result of module review prior to the data collection.

Authors found the quantitative data collection and analysis inappropriate for this research due to necessity of interaction and in-depth discussion with the module leaders and also difficulty to get academics to understand the LSS concept through survey. The semi-structured interview was selected to encourage participants talk openly and widely in order to gain different views and insights, alongside the pre-designed questions. The interview questions have been developed as the result of extensive literature review. The ethical consideration has been taken in account and the formal procedure to meet ethics requirement in the school was completed. The reason to select core modules was to ensure about the highest credibility and coverage of all programmes or courses by selecting the maximum number of the core modules, which are delivered for all students from all programmes.

Then, a qualitative data analysis through content analysis of interview transcripts or some recorded interviews was conducted. The coding framework was selected as a four - steps model to breakdown, analyse, compare and categorise sentences (Aronsson et al, 2011). This was followed by a comparative analysis in which the capacity of the delivered core modules in this school to teach LSS themes has been compared with established LSS training subjects, delivered by the private sector. The presented selected LSS training subjects in the following section is the result of that review and on-line search in various reliable private LSS training sources such as “International Association of Six Sigma Certification (IASSC). Then, and as the last episode of the methodology, following questions were raised to reflect the presented gaps. Both questions one and two reflect all three gaps presented in the figure 1, while question three reflects the justification and effectiveness of this research argument.

Q1) Can current UG and PG modules fit LSS themes in their teaching and assessment structure?

Q2) Can existing programmes or courses fit LSS in their teaching curriculum?

Q3) Can current modules cover the existing private sector LSS training subjects

5-Result

The initial result of the interview analysis indicates that five out of six UG module leaders that were interviewed knew about LSS. The result of interview has also confirmed that all UG modules that were aware of LSS have been concerned with teaching team and whether there would be adequate number of teaching staff, especially for more technical aspects. This has also applied to the Master of Business Administration (MBA) and other PG modules, where all the MBA and most of the PG module leaders were aware of LSS and had concerned about teaching resources. However, this was less critical matter for them, since the module size for PG courses is smaller than UG modules and can be handled with the less teaching staff. It was evident from the teaching material of all of these interviewed UG and PG modules that some of them could incorporate LSS themes and principles such as Total Quality Management (TQM), Lean Management, Statistics, Research Methods, Organisation Improvement, and Leadership without any referral to the LSS. Having presented some overall result of the interview, the following result is presented as the direct analysis for each presented question.

Q1) Can current UG and PG modules in the business school fit LSS themes in their teaching and assessment structure?

The result of the module review and interview presented in table 2 revealed that there are some delivered core level 4 (first year), level 5 (second year), level 6 (final year) and level 7 (PG) modules that can meet or have already met one or more than one LSS theme including the LSS methodologies and their tools and techniques in their teaching structure. It was apparent that only the module leader for the “Management” module, which is a level 4 core module wasn’t aware of the LSS. However, as discussed above, there are different basic and principle leadership and management aspects of the LSS that could be addressed in this module without referral to the LSS. The other UG module leaders were familiar with the LSS relatively and all supported benefits of the LSS to increase the problem solving skills for the UG students through business curriculum. All PG module leaders had some theoretical

knowledge of LSS and initially supported the theoretical benefits of incorporating LSS in the business curriculum.

Module leaders for "Business Processes and Systems" (level 4) and "Business Performance Management" (level 5) both agreed that LSS could be recognised as a potential backbone of the re-development of these modules to make them practically more productive and effective elements in order to complete the learning loop. It was found that the "Solving Business Problems" module in level 4 and the "Business Performance Management" module in level 5 are core modules that can potentially fit more technical aspects such as statistics or some key tools for LSS methodologies. Module leader for the "Business Processes and Systems" module agreed to incorporate some principles of the LSS education such as TQM, Lean and Performance Measurement in his teaching structure. He also agreed to systematically incorporate the LSS definition, benefits, key success factors and barriers of LSS as part of one or two lecture topics for this module. "*It is easy for us to develop the LSS or Six Sigma principles more systematically as part of our operations management lectures as the tail for TQM and Lean Management lectures, and it would even be better if the lecture lies before the statistics lectures in other level 4 modules"*, said the module leader for the "Business Processes and Systems" module.

The module leader for the "Business Performance Management" module also agreed to encounter the DMAIC methodology as part of the teaching structure. *"We are prepared to develop some of our lecture and workshop material as the following chain of Six Sigma related topics in the level 4 modules to provide a systematic business performance improvement tool; this would enhance the practical implications of this module as part of the learning outcomes",* said the module leader for the "Business Performance Management" module. She has also acknowledged the requirement of the staff development and resource management to cover the big range of students from variety of programme backgrounds.

"*This is massively in the favour of this module to present some practical aspects of statistics with a real world examples and through real problem solving methods"*, said the module leader for the "Solving Business Problems" module, when was asked about the benefits of the LSS in their teaching structure. In contrast, he has also acknowledged difficulty of the teaching staff development to incorporate the LSS methodology in their statistical material teaching in a short period of the time. In another scenario and through discussion for other question about the importance of some LSS themes in teaching for the Business Schools, the

module leader for "Business Performance Management" module has emphasised on "process improvement", "variability and defect reduction" and "continuous quality improvement".

In addition, it was found that these two modules alongside a level 6 core module as the "Strategic Management and Leadership" can also potentially cover more business principles and strategic aspects of the LSS in their teaching structure. This was supported by the module leader for the "Strategic Management and Leadership" module to follow the other two modules to support the leadership and strategic aspects of the LSS after learning about more technical and operational aspects. *"We would consider to establish a strong chain of business management and leadership education that could support businesses and I think LSS could be a right example; my main concern is the degree of changes that we might have to do in our teaching content",* Said the module leader for the "Strategic and Leadership Management" module.

The "Business Research Analysis" and the "Analysing Organisations", are level 7 or PG (including MBA) core modules that can potentially cover technical and statistical aspects of the LSS, while business and management - related aspects of the LSS could fit in PG core modules such as the "Operations Management and Organisational Improvement" and the "Managing Sustainable Competitive Advantage". *"We have been covering different areas of organisational excellence and we have already been teaching Six Sigma and Lean in a very limited level; but this can definitely be modified towards these two tools if there is any agenda to promote LSS for PG students",* said the module leader for "Operations Management and Organisational Improvement". His remarks have been reiterated by the researchers in regards to practical implications for PG graduates. The response from module leader wasn't clear since he would not be sure about the cultural elements of the offshore businesses that would be the main employers of the PG graduates who are mainly international.

The "Dissertation" as a UG and also PG core module and the "Work Placement" can be used equivalent to the practical professional project in which students can apply their LSS knowledge in the practice and business environment for a period of 4-5 months project. "*It was clear to us that most of the final year UG and PG students have been doing their dissertation in SMEs if they wished to collect primary data. This has been much more effective process if they have had one year placement with the potential data in their hand",* said the dissertation module leader. The response from dissertation module leader who

coordinates both UG and PG dissertations was positive to encourage students to do some LSS case studies in small scales if it is possible, but he also recognised the issue of supervision, and also the student – led dissertations in this case. *"I am a bit concern that we push students towards certain topics and therefore deter students to select their own research topic as it should be",* said the module leader for dissertations. However, he was happy to start this in a small scale and for a limited number of interested students with supervision from the competent staff at the early stages. It was found that LSS teaching themes can align some UG modules such as the "Solving Business Problems", the "Business Processes and Systems" and the "Business Performance Management" to make a more effective and productive teaching stream.

Table 2

Q2) Can programmes or courses fit LSS in their teaching curriculum?

The result of the programme review, interviews and module review revealed that LSS themes can relatively and under certain depth fit in curriculum of all UG and PG "Business and Management" programmes, since all interviewed core modules are being delivered in the corresponding programmes. Researchers decided to carry out further analysis in relation to the course or programme suitability of the LSS education. Having analysed the programme – specific modules from Business and Management programmes, the module leader of some appropriate programme-specific modules as sample have been interviewed under the purposive sampling strategy. The result of this in-depth analysis, which was presented in the figure three, revealed that some UG programmes with more business and management focus have more compatibility to incorporate LSS themes. This was due to having more focus on LSS themes in some programme-specific modules. The X-axis in the figure three represents the number of core and programme-specific modules in each programme or course (Y-axis) that can fit one or more than one LSS themes in their teaching structure. For instance, delivering modules such as the "Business Research and Reflective Practice" and the "Managing professional skills" for the "Corporate Management" programme have been found as two programme-specific modules that could present the higher degree of LSS methodology in their teaching structure as the tail of what has been delivered in the core

modules. This might make the "Corporate Management" programme as one of the most suitable courses to incorporate the LSS education and perhaps certification.

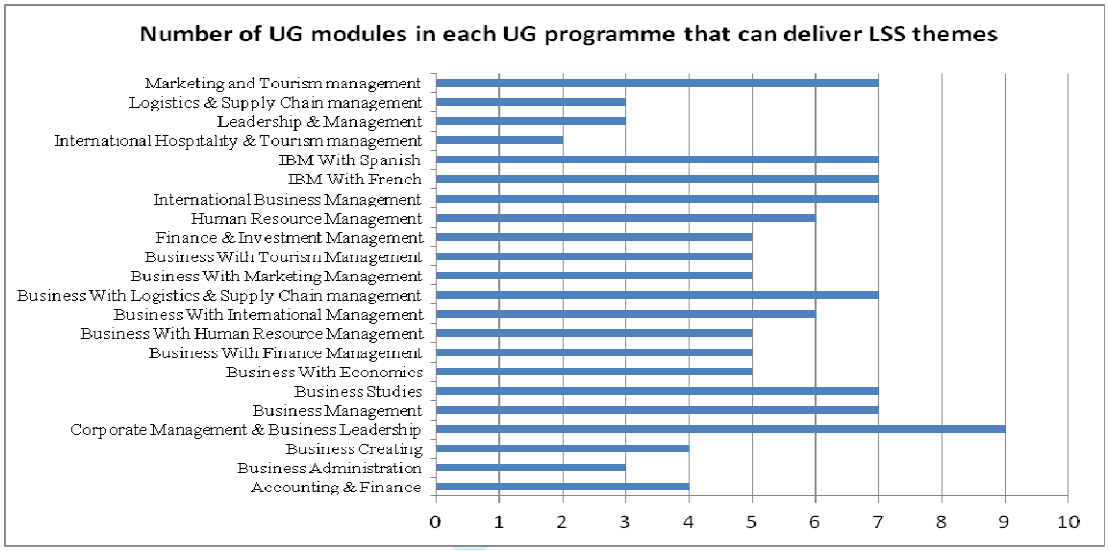

Figure 3 – Number of UG modules in each programme that can deliver LSS themes

The result for PG programmes has suggested that business related programmes such as the "MBA", the "Business with Management", the "Global Business Management" and the "Business with Logistics & Supply Chain Management" have more compatibility to be involved in the LSS teaching modules. This was supported with indication of higher number of the programme-specific modules from these programmes that can fit LSS themes in their teaching structure. The "Work-Based Action Research Project" and "Consultancy Projects" are two practical modules taught in MBA programme that can fit any skill development aspects of LSS problem solving perspective such as implementing methodologies in SMEs. The "Managing Sustainable Supply Chain" is a module that is delivered specifically for the "Global Business management" and the "Business with Global Logistics and Supply Chain Management" programmes that have been found capable to deliver business and strategic aspects of LSS themes such as operations management, project management, performance measurement and process improvement.

Apart from this, since Business and Management students from all programmes will be taught with core modules in all levels (UG and PG), therefore all graduates from Business and Management programmes would have some level of LSS knowledge and skill.

Q3) Can current modules cover the existing private belt- system LSS training subjects?

The result of comparative analysis through on-line sources presented in the table 3 revealed that there are some core and programme-specific modules in this business school that have capacity to meet common required theoretical and practical LSS training and education themes provided in the private sector and therefore, meet professional and practical aspects of the LSS education and training. The result of the interview analysis revealed that all common subjects that have already been covered by the private LSS training providers can be met to the certain level in few core and programme-specific modules from level 4 to level7 to meet one specific belt-training level of the LSS (Black, Green, Yellow) depending upon the level of LSS themes involvement in teaching curriculum. The "Dissertation projects" in both UG and PG courses can be recognised as an equivalent to the professional or practical projects undertaken through private training providers.

The result of interview and also module descriptor and teaching and learning plan review revealed that technical training subjects by the private sector such as applying LSS methodologies, selecting successful LSS projects, and selecting right statistical tools can be taught during first two years of UG study in the business schools (through the business problem solving, the business processes and systems and the business performance management modules), while more business and strategic related subjects such as "Communicating a Business Strategy" can be delivered in the third or final year of study (e.g. strategic management and leadership module). The coverage of these LSS subjects in PG courses is more levelled down and balanced as a few modules have capacity to cover all relevant subjects in their teaching structure. This means that business schools have no disadvantage against the private sector training providers in relation to capacity and capability of teaching required subjects for a LSS education that promotes problem solving skills. The main challenge here is the teaching resource development, which represents the degree of knowledge and experience within teaching team of those modules. This however has not been recognised as a great deal in this studied business school. *"This issue would be gradually solved by sending few potential academic members of staff to the Six Sigma training belts or through actual LSS research project delivery for local SMEs by the academic staff"*, said the module leader for the "Business Processes and Systems" module.

Table 3

5- Research, managerial and business implications:

This research study was conducted in a single case study that could limit validity and significance of this study in the HE sector. A multi-case study analysis involving different business schools or even other faculties or schools could be approached. However, this was not practically possible at the time this research was conducted due to time restrictions. The result of this study was consistent with the literature for the role of business schools to promote more competitive advantage, innovation and distinctiveness in the business education (Worasinchai et al, 2008; Blackman and Kennedy, 2009; and Woods and Dennis, 2009). The LSS integration with the business schools curriculums could potentially increase the opportunity for promoting more innovative and distinctive curriculum with more emphasise on skill development for graduates. The result would also support the literature (Kumar et al, 2011) about requirement of more significant role from business schools to develop the corporate problem solving in SMEs. LSS would have potential to develop this collaboration through establishing its themes in business and management modules.

The result of this study is consistent with the research arguments that had identified a theory/practice gap for LSS and business schools (Reed, 2009, and Antony, 2008). It appears that integrating LSS themes with business and management modules would reduce this gap. This would promote more academia-lead research programmes and research papers in both conceptual and case study aspects of LSS. This study also supports the literature proposal about improving business school competitiveness in the market (Hughes et al, 2009; and Tikhomirava et al, 2008), where LSS integration with HE teaching can potentially develop income generation for HE sector through projects, and providing training sessions for businesses.

The result of this study has addressed the issue of research gap in the LSS that was acknowledged by the literature (Antony, 2012; Antony, 2008; Hilton and Sohal, 2012; and Starkey, 2004). Integrating LSS themes in the business and management modules would encourage academic staff and graduates to be involved in more LSS research activities and collaborate with LSS practitioners. This would consequently promote the collaborative and innovative knowledge development and transfer for business schools that has been recognised as a requirement by the literature (Burke, 2011; Kumaraswamy and Chitale, 2012;

Kumaraswamy and Chitale, 2012; Hughes et al, 2009; Tikhomirova et al, 2008; and Wu and Lin, 2009). This study has addressed the maintenance of governance, cost, and standardisation of LSS training, education and assessment (Antony, 2012; and Laureani, 2012) through proposing a systematic and standardised HE structure in business schools with the sustained quality assurance for LSS training and education.

All highlighted critical academic subjects to succeed in LSS projects have been met in this study. Organisational learning capabilities, leadership (Suresh et al, 2012; and Malik and Blumenfeld, 2012), personal and corporate competence of the project leaders, project team and facilitators (Hilton and Sohal, 2012) and also appropriate technical capabilities (Malik and Blumenfeld, 2012) could fit in the analysed modules for both UG and PG levels.

This study revealed that business schools could potentially enhance graduate's capability to be employed in different sectors that have already been applying LSS. Financial services (Pandry 2007, Antony, 2007; and Delgado, 2010), Human Resource departments (Pandry, 2007; and Chow et al, 2010), information management systems and administration processes (Antony et al, 2012), strategic management and managerial decision making (Friday-Stroud and Sutterfield, 2007), customer satisfaction analysis (Behara et al, 1995) and supply chain management and logistics (Shokri et al, 2010, Nabhani et al, 2009; Narasimhan, 2009; and Aboelmaged, 2010) have all been business and management areas that have been targeted by LSS projects and have also been established as either a business programme or an academic teaching context in the studied business school.

It appears that this research study could promote a closer collaboration between SMEs and business schools through a theoretical and professional approach. This collaboration would be strengthen through sustainable knowledge and skill development for business school graduates that can establish a greater impact on SME requirements for problem solving skills. This would potentially increase the employability of graduates, while improve performance of SMEs continuously. It will also develop an enhanced and effective curriculum in business schools, ultimately resulting in developing more innovative and competitive business schools.

6-Concluding remarks and future work

It was concluded that LSS education can be established in both UG and PG levels in business schools through a standard teaching and assessment structure of both core and programme-

specific modules to promote skill development, innovation and competitiveness. It will potentially provide graduates with a theoretical and practical knowledge and skill of problem solving with a reliable and standard assessment and certification, which is required by the SME managers. The teaching structure in business schools, which cover both theoretical and practical perspectives, will underline the common LSS training themes that are required for a young graduate equivalent to certain levels of the LSS Belt training. Therefore, it was concluded that business schools can have a significant role to reduce the existing knowledge transfer gap and to reduce the research gap in the LSS practice, if they apply a structured LSS education as part of their curriculum.

This research study has been limited to a qualitative approach within a single business school, and this could be extended to more quantitative methods after the pilot study in some modules or programmes in one business school or for other business and engineering schools. This research study recommends the necessity of establishing a LSS – oriented teaching in all business schools in a smaller scale such as continuous re - engineering and re - designing of some core modules in a certain period of time. There is a vast opportunity for the further research study in order to highlight the gaps and provide more detailed aspect of LSS role in reducing the gap between business schools, graduates' employability and SMEs problem solving required skills. The researchers believes that the same type of research could also be applied for the engineering schools, where there is the same gap and also high compatibility between LSS teaching and curriculum of engineering schools in practice similar to business schools.

There is a need for more extensive review of other business schools. There are also some practical implications to be considered such as school/university-wide policies, admission and logistical limits to design a new programme or a new module, and also operational and administrative issues of modifying different modules under different leadership.

References

Aboelmaged, M.G. (2010), "Six Sigma quality: a structured review and implications for future research", *International Journal of Quality and Reliability Management*, Vol. 27 No. 3, pp. 268-317.

Alferoff, C. and Knights, D. (2009), "Making and mending your nets: managing relevance, participation and uncertainty in academic-practitioner knowledge networks", *British Journal of Management*, Vol. 20 No. 18, pp. 125-140.

Anninos, L. N. and Chytiris, L. (2011), "Searching for excellence in business education", *Journal of Management Development,* Vol. 30 No. 9, pp. 882-892.

Antony, J.; Kumar, M.; and Madu, C.N. (2005), "Six Sigma in Small - and -medium sized UK manufacturing enterprises", *International Journal of Quality & Reliability Management,* Vol. 22 No. 8, pp. 860-874.

Antony, J. (2007), "Six Sigma: a strategy for supporting innovation in pursuit of business excellence", *International Journal of Technology Management*, Vol. 37 No. ½, p. 8.

Antony, J. Antony, F.J. and Kumar, M. (2007), "Six Sigma in Service organisations", *International journal of quality & reliability management,* Vol. 24 No. 3, pp. 294-311

Antony, J. (2008), "What is the role of academic institutions for the future development of Six Sigma", *International Journal of Productivity and Performance Management*, Vol. 57 No. 1, pp. 107-110.

Antony, J. (2008), "Can Six Sigma be effectively implemented in SMEs?", *International Journal of Productivity and Performance Management,* Vol. 57 No. 5, pp. 420-423.

Antony, J. and Desai, D.A. (2009), "Assessing the status of six sigma implementation in the Indian industry", *Management research News*, Vol. 32 No**.** 5, pp.413-423.

Antony, J. (2007), "Six Sigma and its role in financial services", *The TQM Magazine*, Vol. 19 No. 5.

Antony, J. Bhuller, A.S. Kumar, M. Mendibil, K. and Montgomery, D.C. (2012), "Application of Six Sigma DMAIC methodology in a transactional environment", *International Journal of Quality and Reliability Management,* Vol. 29 No. 1, pp. 31-53.

Antony, J. (2012), "A SWOT analysis on Six Sigma: some perspectives from leading academics and practitioners", *International Journal of Productivity and Performance Management,* Vol. 61 No. 6, pp. 691-698.

Antony, J. (2014), "Readiness factors for the Lean Six Sigma journey in the higher education sector", International Journal of Productivity and Performance Management, Vol. 63 No. 2, pp. 257-264.

Aronsson, H. Abrahamsson, M. and Spens, K. (2011), "Developing lean and agile health care supply chain", *Supply Chain Management: An International Journal*, Vol. 16 No. 3, pp. 176-183.

Assarlind, M. Gremyr, I. and Backman,K. (2013), "Multi – faceted views on a LSS application", *International Journal of Quality and Reliability management*, Vol. 29 No. 1, pp. 21-30.

Behara, R. S. Fontenot, G.F. and Gresham, A. (1995), "Customer satisfaction measurement and analysis using Six Sigma", *International Journal of Quality and Reliability management*, Vol. 12 No. 3, pp. 9-18.

Bickerstaffe, G. and Ridgers, B. (2007), "Ranking of Business Schools", *Journal of Management Development,* Vol. 26 No. 1, pp. 61-66.

Biranvand, A. and Khasseh, A. A. (2013), "Evaluating the service quality in the regional information centre for science and technology using the Six Sigma methodology", Library management, Vol. 34 No. ½, pp. 56-67.

Blackman, D. and Kennedy, M. (2009), "Knowledge management and effective University governance", *Journal of Knowledge Management*, Vol. 13 No. 6, pp. 547-563.

Brun, A. (2011), "Critical success factors of Six Sigma implementations in Italian companies", *International Journal of Production Economics*, Vol. 131 No.1, pp. 158-164.

Buch, K.K. and Tolentino, A. (2006), "Employee expectancies for six sigma success", *Leadership & Organisation Development Journal,* Vol. 27 No. 1, pp. 28-37.

Burke, M.E. (2011), "Knowledge sharing in emerging economies", *Library Review*, Vol. 60 No. 1, pp. 5-14.

Cho, J.H.; Lee, J.H.; Ahn, D.G.; and Jang, J.S. (2011), "Selection of six Sigma key ingredients in Korean Companies", *The TQM Journal*, Vol. 23 No. 6, pp. 611-628.

Chow, A.F.; Gillespie Finney, T.; and Woodford,C. (2010), "Training design and transfer: contributions of Six Sigma", *International Journal of Productivity and Performance Management,* Vol. 59, No. 7, pp. 624-640.

Delgado, C. Ferreira, M. and Branco, M.C. (2010), "The implementation of lean Six Sigma in financial services organisations", *Journal of Manufacturing and Technology Management*", Vol. 21 No. 4, pp. 512-523.

Friday-Stroud, A. and Sutterfield, S. (2007), "A conceptual framework for integrating Six Sigma and strategic management methodologies to quality decision making", *The TQM Magazine*, Vol. 19 No. 6, pp. 561-571.

Gijo, E.V. Antony, J. Kumar, M. McAdam, R. and Hernandez, J. (2014), "An application of Six Sigma methodology for improving the first pass yield of a grinding process", Journal of Manufacturing Technology management, Vol. 25 No. 1, pp. 125-135.

Hamel, G. (2009), "Moon shots for management", *Harward Business Review*, Vol. 87, pp. 91-98.

Harrington, D. and Kearney, A. (2011), "The business school in transition", *Journal of European Industrial Training*, Vol. 35 No. 2, pp. 116-134.

Hilton, R.J. and Sohal, A. (2012), "A conceptual model for the successful deployment of LSS", *International Journal of Quality and Reliability Management*, Vol. 29 No. 1, pp. 54-70.

Hofer, F. (2005), "Knowledge transfer between academy and industry", *in Schartz, D.G.(ed), Encyclopaedia of Knowledge Management,* Indea Group Publishing, Hershy, PA.

Hughes, T. O'Regan, N. and Sims, M.A. (2009), "The effectiveness of knowledge networks, an investigation of manufacturing SMEs", *Education + Training*, Vol. 51 No. 8/9, pp.665-681.

Kaushik, P. Khanduja, D. Mittal, K; and Jaglan, P. (2012), "Application of Six Sigma methodology in a small and medium – sized manufacturing enterprise", *TQM Journal*, Vol. 24 No. 1, pp. 4-16.

Kieser, A. and Leiner, L. (2009), "Why the rigour relevance gap in management research is unbridgeable", *Journal of Management Studies*, Vol. 46 No. 3, pp. 516-533.

Kumar, M. Antony, J.; and Tiwari, M.K. (2011), "Six Sigma implementation framework for SMEs – a roadmap to manage and sustain the change", *International Journal of Production Research*, Vol. 49 No. 18, pp. 5449-5467.

Kumar, M.; Antony, J.; and Douglas, A. (2009), "Does size matter for Six Sigma implementation?", *The TQM journal,* Vol. 21 No. 6, pp. 623-635.

Kumaraswamy, K.S.N. and Chitale, C.M. (2012), "Collaborative knowledge sharing strategy to enhance organisational learning", *Journal of Management Development,* Vol. 31 No. 3., pp. 308-322.

Laureani, A. and Antony, J. (2012), "Standards for LSS certification", *International Journal of Productivity and Performance Management,* Vol. 61 No. 1, pp. 110-120.

Lee, T.Y.; Wong, W.K.; and Yeung, K.W. (2011), "Developing a readiness self-assessment model (RSM) for Six Sigma for China enterprises", *International Journal of Quality and reliability management*, Vol. 23 No. 2, pp. 169-194.

Lee-Mortimer, A. (2006), "Six Sigma: a vital improvement approach when applied to the right problems, in the right environment", *Assembly Automation,* Vol. 26 No. 1, pp.10-17.

Malik, A. Blumenfeld, S. (2012), "Six Sigma, quality management systems and the development of organisational learning capability", *International Journal of Quality and Reliability Management*, Vol. 29 No.1, pp.71-91.

Manville, G. Greatbanks, R. Krishnasamy, R. and Parker, D.W. (2012), "Critical success factors for LSS programmes: a view from middle management", *International Journal of Quality and Reliability Management*, Vol. 29 No.1, pp. 7-20.

Nabhani, F. Shokri, A. (2009), "Reducing the delivery lead time in a food distribution SME through the implementation of Six Sigma methodology", *International Journal of Manufacturing Technology Management,* Vol. 20 No. 7, pp. 957-974.

Narasimhan, K. (2009), "Lean Six Sigma for Supply Chain Management: The 10-step solution process", *The TQM Journal*, Vol. 21 No. 6. pp. 637-638.

Nonaka, I. Toyama, R.; and Konno, N. (2000), "SECI, Ba and leadership: a unified model of dynamic knowledge creation", *Long Range Planning*, Vol. 33 No. 1, pp. 5-34.

Noroda, N. (2011), "Future business schools", *Journal of Management Development,* Vol. 30 No. 5, pp. 519-525.

Pandey,A., (2007), "Strategically focused training in Six Sigma way: a case study", *Journal of European Industrial Training*, Vol. 31 No.2, pp.145-162.

Pepper, M.P.J.; and Spedding, T.A. (2010), "The evolution of LSS", *International Journal of Quality and reliability Management,* Vol. 27 No. 2, pp. 138-155.

Prashar, A. (2014), "Adoption of Six Sigma DMAIC to reduce cost of poor quality", International Journal of Productivity and Performance Management, Vol. 63 No. 1, pp. 103-126.

Ranjan, J. (2011), "Study of sharing knowledge resources in business schools", *The Learning Organisation*, Vol. 18 No. 2, pp. 102- 114.

Ray, J.L. Baker,L. and Plowman, D.A. (2011), "Organisational mindfulness in Business Schools", *Academy of Management Learning and Education*, Vol. 10 No. 2, pp. 188-203.

Reed, M.I. (2009), "The theory/practice gap: a problem for research in business schools?", *Journal of Management Development*, Vol. 28 No. 8, pp. 685-693.

Scarborough, H. and Knights, D. (2009), "In search of relevance", *Organisation Studies*.

Shokri, A. Nabhani, F. Hodgson, S. (2010), "Supplier development practice: arising the problems of upstream delivery for a food distribution SME in the UK", *Robotics and Computer Integrated Manufacturing*, Vol. 26, pp. 639-646.

Starkey, K. and Tempest, S. (2008), "A clear sense of purpose? The evolving role of the business school", *Journal of Management Development*, Vol. 27 No. 4, pp.379-390.

Starkey, K. Hatchuel, A. and Tempest, S. (2004), "Rethinking the Business School", *Journal of Management Studies*, Vol. 41 No. 8, pp. 1521-1531.

Suresh, S. Antony, J. Kumar, M.; and Douglas, A. (2012), "Six Sigma and leadership: some observations and agenda for future research", *The TQM Journal,* Vol. 24 No.3, pp. 231-247.

Tata, R.M. and Jones, G.D. (2011), "Six Sigma culture as a management principle", *GSABC Journal of Blood Services*, Vol. 51, pp. 1604 – 1608.

Tikhominova, N. Gritsenko, A. and Pechenkin, A. (2008), "University approach to knowledge management", *VINE: The Journal of Information and Knowledge Management Systems,* Vol. 38, No. 1, pp. 16-21.

Tracy Zou, X.P. and Lee, W.B. (2010), "A study of knowledge flow in Six Sigma teams in Chinese manufacturing enterprise", *VINE: The Journal of Information and Knowledge Management Systems*,Vol. 40 No. 3 / 4, pp. 390-403.

Woods, A. and Dennis, C. (2009), "What do UK small and medium sized enterprises think about employing graduates?", *Journal of Small Business and Enterprise Development*, Vol. 16 No. 4., pp.642-659.

Worasinchai, L. Ribere, V.M. and Arntzen, A.A.B. (2008), "Working knowledge, the university-industry linkage in Thailand: concepts and issues", *The Journal of Information and Knowledge Management Systems*, Vol. 38 No. 4. Pp. 507-524.

Wu, C. and Lin, C. (2009), "Case study of knowledge creation facilitated by Six Sigma", *International Journal of Quality and Reliability management*, Vol. 26 No. 9, pp. 911-932.

[1] iSix Sigma, http://store.isixsigma.com/product/Training-Materials--Aids/six-sigma/Six-Sigma-Black-Belt-Training-Course v11?utm_source=iSixSigma&utm_medium=RokTabs&utm_campaign=CrossPromote

LSS Themes	Gap 1 – inability of business schools to provide required workforce for SMEs	Gap 2 – lack of practical knowledge and skill for graduates provided by business schools	Gap 3 – difference between SMEs' perception and expectation from graduates
Statistical Problem Solving Tools	Graduates are able to systematically collect data and solve problems in SMEs	Graduates learn problem solving and decision making skill and knowledge to be used in practice	Graduates can be involved in decision making process with having practical systematic problem solving skill
Performance Measurement Tools	Graduates learn about theories and skills of data collection, data analysis and performance measurement tools and techniques		Graduates can build trust by proposing some professional aspects of performance measurement
Process Improvement Methodology	Graduates learn a systematic process improvement methodology with professional usage for any sector		Graduates can be involved in decision making process with practical skill in sustainable improvements
Project management	Practical Project Management skills of graduates would be developed and assessed with integration with practical problem solving tools and techniques during dissertation projects		Graduates can practically lead sustainable problem solving or business improvement projects in SMEs
Operations Management	Graduates would be able to be involved in problem solving, improvement and performance measurement of all operations in planning, sourcing, making, delivering and sales processes		Graduates gain more confident to be involved in decision making and project management of all operations
Leadership	LSS leadership focuses on both practical and theoretical aspects		Decision Making tools will be taught through LSS teaching

Table 1 – Role of LSS themes to minimise the proposed gaps

LSS Themes in Training & Education	Core Module	Problem Solving Tools	Performance Measurement Tools	Process Improvement Methodology	Project Management	Operations Management	Leadership
UG Level 4 Modules							
Solving Business Problems	√	√	√				
Business Processes & Systems	√	√	√	√	√	√	
Management	√				√	√	√
UG Level 5 Modules							
Business Performance Management	√	√	√	√	√	√	√
UG Level 6 Modules							
Strategic Management & Leadership	√			√	√	√	√
Dissertation & Professional Project	√	√	√	√	√		
MBA Modules							
Business Research Analysis	√	√	√	√			
Operations Management & Organisational Improvement	√	√	√	√	√	√	√
Dissertation	√	√	√	√	√		
Research methods	√	√	√	√	√		
Other Postgraduate Modules							
Business Research Analysis	√	√	√	√			
Analysing Organisation	√	√	√	√	√		
Managing Sustainable Competitive Advantage	√	√	√	√	√	√	√
Business Environment & Strategic Management	√			√	√	√	√
Dissertation	√	√	√	√	√		
Research methods	√	√	√	√	√		

Table 2 - Core UG and PG modules in the Business School to incorporate LSS in their teaching structure

	Respective Core Modules of the Business School			
Delivered Subjects in a private Belt system LSS training	**UG Level 4**	**UG Level 5**	**UG Level6**	**PGT & MBA**
Communicating a business strategy across the organisation			Strategic Management & Leadership	Business Environment & Strategic Management
Integrating with Lean Manufacturing, TOC, & other improvement methods	Business Processes & Systems		Dissertation	Business Environment & Strategic Management, Dissertation
Applying the DMAIC improvement process	Business Processes & Systems & Business Problem Solving	Business Performance Management	Dissertation	Operation Management & Organisational Improvement, Managing Sustainable Competitive Advantage
Selecting successful Six Sigma projects and project teams	Business Processes & Systems	Business Performance Management	Dissertation	Business research Analysis, Analysing Organisation, Managing Sustainable Competitive Advantage, Dissertation
Planning and executing projects		Business Performance Management	Strategic Management & Leadership, Dissertation	Dissertation
Benefits of Six Sigma projects	Business Processes & Systems		Dissertation	Operation Management & Organisational Improvement, Analysing Organisation
Selecting the right statistical tools	Business Problem Solving	Business Performance Management	Dissertation	Business Research Analysis, Dissertation
Six Sigma philosophy of process improvement	Business Processes & Systems	Business Performance Management	Dissertation	Operation Management & Organisational Improvement, Managing Sustainable Competitive Advantage
Customer centred business	Business Processes & Systems	Business Performance Management	Strategic Management & Leadership, Dissertation	Operation Management & Organisational Improvement, Managing Sustainable Competitive Advantage
Lean principles	Business Processes & Systems	Business Performance Management		Operation Management & Organisational Improvement, Managing Sustainable Competitive Advantage, Dissertation
Statistics	Business Problem Solving		Dissertation	Business Research Analysis, Analysing Organisations, Dissertation
Group/organizational assessment			Dissertation	Dissertation

Table 3 – Respective Core modules in business school to meet common high street LSS training subjects